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ABSTRACT

The process of establishing an individualized mathematics program is discussed. An annotated list of references covering program and course goals and objectives, diagnostic and achievement tests, teacher reference books, and activity sources is provided. Twenty-one articles from "The Arithmetic Teacher" which offer a rationale for the activity approach and which suggest suitable activities are also listed. Addresses are provided for 16 commercially produced activity cards and packages and for 15 sources of mathematics laboratory equipment, games, and enrichment materials. (DT)

RESOURCES FOR INDIVIDUALIZING MATHEMATICS

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If he is indeed wise he does not bid you enter the house of his wisdom, but rather leads you to the threshold of your own mind.

Kahil Gibran

Foreword

Judging from its use in commercially produced materials, educational journals, instructional programs and elsewhere, the word "individualization" has many interpretations and is used in various degrees. Too often it is applied as a catch-word to add appeal to products and programs which have little similarity. This loose usage causes confusion in education which becomes apparent when an effort is made to individualize a school's program.

Leading educators suggest that an individualized program should be based on the premise that the learning process is a personal undertaking. It should have some means of diagnosing each student, prescribing instructional activities and materials that are suited to him and also a means of recording his progress. The program should be child-centered and, in most subject areas, activity-oriented. It should also evidence the fact that individuals possess different learning styles as well as learning rates.

This conception contrasts sharply with the majority of mathematics programs which claim to be individualized. In most cases, such programs require that the student proceed through the same content material at the student's own pace. The only variable considered is the rate of

learning. According to the description offered above, these programs fall short of being fully individualized. A more complete program would consider the student's needs and interests, as identified by diagnostics and student input, and would allow students to undertake alternative activities, under differing environments, in the pursuit of competencies in pre-established objectives.

Implementing and operating such a program in Mathematics obviously requires more time and energy. The purpose of this paper is to point out resources and materials which would be helpful in this effort

Introduction

The process of establishing an individualized mathematics program can be sequenced in the following three phases:

1. The identification of program goals, a statement of philosophy and expected student outcomes,
2. Development of course objectives and performance indicators,
3. Identification and accumulation of instructional materials and activities that would be used to individuzlize the learning paths in pursuit of said goals and objectives.

Although references are cited for all three phases, it is felt that the products of the first two should essentially be developed locally. It is in this spirit that these references are listed as guidelines. A more complete listing has been provided for the implementation of phase three.

Phase 1: The Identification of Program and Course Goals:

This effort should ideally result in a local statement on the philosophy of mathematics education and a listing of program goals, both product and process. The following resources are offered as guidelines in this undertaking:

a/ Course Goals in Mathematics: Grades K - 12, by the Tri-County Goals Development Project. Information and copies may be obtained by contacting:

Robert Allenbrand
Project Coordinator
Multnomah County Intermediate
Education District
P.O. Box 16657
Portland, Oregon 97216

This resource, mentioned again in stage two, has pages which are color coded. Mathematical program goals appear on the blue pages. These materials are intended to be used as suggested goals to which modifications can be made and other goals added.

b/ Freedom to Learn: An Active Learning Approach to Mathematics,

by Edith Biggs, James R. MacLean, 1969.
Addison Wesley (Canada) Ltd.
57 Gervais Drive
Don Mills, Ontario, Canada

This resource would apply to each of the three phases mentioned since it devotes adequate space to each. According to the authors,

> "This book has been written to assist students preparing for a teaching career, experienced teachers, administrators and all other interested in children and education to

become more familiar with an active learning approach. In particular, we have tried to use mathematics to describe what distinguishes an active learning approach and how it may be implemented."

In regards to Phase 1, the first chapter, "Learning by Doing", offers a philosophical base for individualizing mathematical instruction. It also contains a fine bibliography of other sources (pages 42-43).

c/ Guide to Elementary (Secondary) Education in Oregon, State Department of Education, 1964 (1966).

Both guides contain short listings of program goals which were adapted from textbook adoption criteria.

Phase 2: Development of Course Objectives and Performance Indicators

The process of identifying course objectives is a valuable experience for all teachers. It establishes a broad overview of each course which is difficult to obtain from weekly plans. It may also be revealing how many topics can be added, deleted or extended. Suggested references are:

a/ Course Goals in Mathematics, Tri-County Goal Development Project (cited in 1b/).

These materials are currently in a state of revision. Their present state reflects course goals which are primarily product oriented and revisions include the adding of process goals.

b/ Freedom to Learn, Biggs and MacLean, (cited above)

Course objectives appear throughout the book with examples of performance indicators as well.

c/ Stating Behavioral Objectives for Classroom Instruction, Norman E. Gronlund, The Macmillan Company, 1970, ($1.50). Gronlund utilizes Bloom's Taxonomy and focuses attention on higher level cognitive objectives. Krathwohl's Taxonomy of Educational Objectives in the Affective Domain is also shown and examples given. The addition of his Psychomotor Taxonomy makes this a very complete resource for this phase.

Phase 3: Identification and Accumulation of Instructional Materials and Activities

Implementing an individualized mathematics program involves acquiring diagnostic instruments, record keeping and reporting devices, audio-visual equipment, books and sets of activities--all of which can be grouped under the heading of Instructional Materials. The suggested references that follow are organized accordingly and many offer materials which overlap.

A. Diagnostic/Achievement Tests

i/ A Guide to the Diagnostic Teaching of Arithmetic, Fredricka K. Reisman, Charles E. Merrill Publishing Company, 1972 ($2.50). An excellent "How to" book for the development of criterion referenced diagnostic and achievement tests. Examples of tests and test items serve as guidelines and a list of commerically produced diagnostic tests is also provided. Ideas of how to develop record keeping and reporting devices help complete the book.

ii/ Mathematics Tests Available in the United States, Sheldon S. Myers, Floyd G. Delon, National Council of Teachers of Mathematics, 1969 ($1.10).

Lists tests by author, grade levels and forms, availability of norms, publisher, reference in Mental Measurements Yearbook, original and latest publication dates.

It should be noted that discussions with students and observations of their mathematical activities are essential components to both diagnostics as well as to the measurement of achievement.

B. Teacher Reference Books and Activity Sources

i/ A Cloudburst of Math Lab Experiments, Donald Buckeye, William Ewbank, John Ginther, 1971. (Softcover $2.95-$3.95 per vol., card form $12.00-$22.00).

Midwest Publications
P.O. Box 307
Birmingham, Michigan 48012

Four softcover booklets (or four sets of cards) and a teacher's guide ($1.50) provide suggestions for approximately 1000 experiments, many of them involving apparatus and particularly suitable for low achievers; there is a wide range of material available for students, grades 5-14. Most of the equipment needed can be improvised without much cost.

ii/ A Handbook of Aids for Teaching Junior-Senior High School Mathematics by Stephen Krulek, ($2.95)

W.B. Sanders Company
West Washington Square
Philadelphia, Pennsylvania 19105

This book shows how to use common materials--such as waxed paper, thread, posterboard and file cards in the mathematics classroom. The devices are intended for student use to allow him to become involved as an active learner. Aids are divided into categories such as arithmetic, algebraic, geometric, etc.

iii/ Activities in Mathematics, Donovan Johnson, Viggo Hansen, Wayne Peterson, Jesse Rudmick, Ray Cleveland, Carey L. Bolster,

Scott-Foresman
99 Bauer Drive
Oakland, California 94304

Two courses contained in eight consumable books, organized around patterns, numbers, measurement, probability, graphs, statistics, proportions, and geometry. Definitely oriented to activities; tossing dice, curve stiching and investigation of puzzles and problems. (Grades 5-9).

iv/ Children Explore Mathematics, L.G. Marsh,

A & C Black
5 Solo Square
London, W1V6AD

A book for teachers with many practical suggestions for helping develop an understanding of the power of mathematics.

v/ Fabric of Mathematics, Mary Laycock and Gene Watson, ($12.50)

Creative Publications
P.O. Box 10328
Palo Alto, California 94303

Unique resource book designed to help teachers present an individualized and activity-centered math program. Includes a scope and sequence of 91 concepts with listing of activities, games

and other materials that can be used for each concept. Each is clearly defined and supported by behavioral objectives and assessments for various levels. Authors have included only those things which they have classroom tested. Assessment check sheets are available separately ($2.50 for 30). Grades K - 8.

vi/ Franklin Mathematics Series

Franklin Publications, Inc.
367 S Pasadena Avenue
Pasadena, California 91105

At this time there are 11 books in this series, four of them consumable. They are aimed at grades 3-8, and are beautifully written and illustrated. They provide hundreds of ideas for worthwhile mathematical investigation.

vii/ Freedon to Learn, Biggs, MacLean (cited above)

viii/ How Children Learn Mathematics, Teaching Implications of Piaget's Research, Richard Copeland, 1970.

The Macmillan Company
366 Third Avenue
New York, New York 10022

As described by the author, "This book is intended to serve two major purposes. One is diagnostic--that is, to aid in discerning a child's stage of development as a basis for determining the type of mathematics for which he is ready. The second major purpose is to serve the "methods of teaching mathematics" courses in teacher education. The reader will find it very different from the other methods texts because it is based on "how children learn", "not how to teach." It will enable the reader to see mathematics from the standpoint of the child as he progresses through the various stages of development."

ix/ How to Start a Math Lab, Donald Cohen, Charlotte Frank, Bernard Kessler

Olivetti Education Center
155 White Plains Road
Tarrytown, New York 10591

This booklet is one of several published by the Olivetti Education Center. It reflects the philosophy that "the most constructive approach for today's teacher is to concentrate on making his pupils aware of 'how to learn' rather that 'what to learn'.... children who have been taught to think humanely, creatively and critically will be well equipped to deal with an unknown and rapidly changing world."

x/ Laboratory Manual for Elementary Mathematics, Fitzgerald, Bellamy, Boonstra, Jones and Oosse, Creative Publications Company, (address above).

A manual designed to be used in an activity - oriented mathematics laboratory for elementary teachers or prospective teachers. All sixteen units are independent of each other. Activities and materials were chosen to encourage student enthusiasm, interest and achievement in mathematics.

xi/ Math Activities for Child Involvement, Enoch Dumas, 1971

Allyn and Bacon, Inc.
470 Atlantic Avenue
Boston, Massachusetts

This book offers hundreds of suggestions for activities (games, puzzles, projects, manipulative materials) and is organized around major topics in elementary school mathematics.

xii/ Mathex Units

Encyclopedia Britannica Publishers, Ltd.
151 Bloor Street West
Toronto 5, Canada

A new publication which features six units on both primary and elementary levels. Each unit contains many discovery activities that teach to specific objectives. The Introduction booklet for teachers is invaluable as a classroom management guide. It features excellent suggestions and diagrams of room arrangements, learning station organizations and general suggestions on implementing an activity approach to mathematics.

xiii/ Notes on Guidelines in School Mathematics, Mathematics Department of the Manchester College of Education, 1970

Rupert Hart-Davis Educational Publications
3 Upper James Street
London, W1R4BP

Guidelines in School Mathematics is a chart "designed for teachers and teachers in training to assist them in relating particular ideas in school mathematics to an over-all picture.

Notes on Guidelines...is a book describing activities related to the topic cited in the chart. The suggestions are thoughtful and pertinent. Both the chart and the book would be very helpful.

xiv/ Notes on Mathematics in Primary Schools, Members of the Association of Teachers of Mathematics,

Cambridge University Press
32 East 57th Street
New York, New York 10016

Describes a philosophy for using laboratory approaches, some classroom situations and offers some exercises for the teacher

xv/ Nuffield Mathematics Guides

John Wiley and Sons, Inc.
605 Third Avenue
New York, New York 10016

These books, (there are nine at this time) written by teachers in England, provide excellent descriptions, suggestions and rationale relative to laboratory approaches. An interested teacher would be wise to begin with these. They have a distinctively high quality.

xvi/ The Geoboard: A Manual for Teachers, Kreitzberg, 1970

Walker Publishing Company
720 Fifth Avenue
New York, New York 10019

Presents problems suitable for geoboard work, grades K-5.

xvii/ Young Math Books

Thomas Y. Crowell Company
201 Park Avenue South
New York, New York 10003

These help satisfy an urgent need for good books suitable for primary grade children and oriented to activities and independent mathematical investigations. At this writing eight books in this series are available.

C. Articles from THE ARITHMETIC TEACHER, 1966-1971

These entries are not individually annotated. They identify articles which offer a rationale for using activity approaches or suggest problems suitable for independent student investigations.

i/ Biggs, Edith E. "Mathematics Laboratories and Teachers' Centres - the Mathematics Revolution in Britian." 15 (May 1968): 400-408.

ii/ Biggs, Edith E. and Hartung, Maurice L. "The Role of Experience in the Learning of Mathematics." 18 (May 1971): 278-95.

iii/ Buchman, Aaron L. "An Experimental Approach to the Pythagorean Theorem." 17 (February 1970): 129-32.

iv/ Davidson, Patricia S. "An Annotated Bibliography of Suggested Manipulative Devices." 15 (October 1968): 509-24.

v/ Davidson, Patricia and Fair, Arlene. "A Mathematics Laboratory - From Dream to Reality." 17 (February 1970): 105-10.

vi/ Egsgard, John C. "Geometry All Around Us - K-12." 16 (October 1969): 437-45.

vii/ Fitzgerald, William M. "A Mathematics Laboratory for Prospective Elementary School Teachers." 15 (October 1968): 547-49.

viii/ Hamilton, E.W. "Manipulative Devices." 13 (October 1966): 461-67.

ix/ Leeb-Lundberg, Kristina. "Kindergarten Mathematics Laboratory - Nineteenth Century Fashion." 1/ (May 1970): 372-86.

x/ Matthews, Geoffrey. "The Nuffield Mathematics Teaching Project." 15 (February 1968): 101-2.

xi/ May, Lola. "Individualized Instruction in a Learning Laboratory Setting." 13 (February 1966): 110-12.

xii/ May, Lola J. "Learning Laboratories in Elementary Schools in Winnetka." 15 (October 1968): 501-03.

xiii/ Morgenstern, Francis and Pincus, Morris. "Graphs in Primary Grades." 17 (October 1970): 499-501.

xiv/ Ogletree, Earl. "Geometry: An Artistic Approach." 16 (October 1969): 457-61.

xv/ Sullivan, John J. "Problem Solving Using the Sphere." 16 (January 1969): 29-32.

xvi/ Sullivan, John J. "Some Problems in Geometry." 14 (February 1967): 107-9.

xvii/ Vaughn, Ruth K. "Investigation of Line Crossing in a Circle." 18 (March 1971): 157-60.

xviii/ Walter, Marion. "An Example of Informal Geometry: Mirror Cords." 13 (October 1966): 488-52.

xix/ Walter, Marion. "A Second Example of Informal Geometry: Milk Cartons." 16 (May 1969): 368-70.

xx/ Walter, Marion. "Some Mathematical Ideas Involved in the Mirror Cords." 14 (February 1967): 115-25.

xxi/ Weaver, J. Fred. "Seductive Shibboleths." 18 (April 1971): 263-64.

D. Commercially Produced Activity Cards and Packages

i/ Activity Cards for Independent Exploration, Concept Company, Box 273, Belmont, Massachusetts 02178.

ii/ Applied Mathematics Cards, Schofield & Sims Ltd., 35 St. John's Road, Huddersfield, England

iii/ Geocards, by Donald Cohen, Walker & Company, 720 Fifth Avenue, New York, New York 10019

iv/ Green and Red Cards for Grades 6 to 9, John Wiley and Sons, Nuffield Project, New York, New York 10016

v/ Independent Exploration Material, by Madison Project, Math Media Division, H & M Associates, Box 1107, Danbury, Connecticut 06810.

vi/ Let's Play Games in Mathematics, George Henderson, National Textbook Company, 8259 Niles Center Road, Skokie, Illinois 60076

vii/ Math Action, Copp Clark Publishing Company, Montreal, Canada

viii/ Math Lab, Jack Hood School Supplies Company, Inc., 91-99 Erie Street, Stratford, Ontario, Canada

ix/ Mathematics Mini-Lab, by Donald Cohen, SEE 3 Bridge Street, Newton, Massachusetts 02195

x/ Mathex, Encyclopedia Britannica Publishers, Ltd., 151 Bloor Street West, Toronto 5, Canada

xi/ Mira Math for Elementary Schools (transformational geometry and activities with symmetrics) Mira Math Company, P.O. Box 625, Station B, Willowdale, Ontario, Canada

xii/ Mirror Cards, Problem Cards for the Attribute Games, and other Elementary Science Study Math materials, McGraw-Hill Book Company, Webster Division, Manchester, Missouri 63011

xiii/ Retriev-o-math Activity Cards, by Eugene P. Smith and Carlos Wilhite, Midwest Publications Company, Inc., Box 307, Birmingham, Michigan 48012

xiv/ Student Activity Cards for Cuisenaire Rods, by Galton et al Cuisenaire Company of America, Inc., 12 Church Street, Now Rochelle, New York 10805

xv/ Tasks and Manual for Use with the Multi-Base Arithmetic Blocks, by Dienes, Herder & Herder, New York, New York 10016

xvi/ The MacMillan Math Activity Cards, by David Clarkson, MacMillan Company, Toronto, Ontario, Canada

E. Sources of Math Lab Equipment, Math Games, and Enrichment Materials

(Catalogs will be sent upon request to publisher)

Concept Catalogs

Concept
Box 273
Belmont, Massachusetts 02178

Creative Publications

Creative Publications
P.O. Box 328
Palo Alto, California 94302

Cuisenaire Aids for Learning Mathematics Catalog

Cuisenaire Company of America, Inc.
12 Church Street
New Rochelle, New York 10805

Developmental Learning Materials

Developmental Learning Materials
3505 N Ashland Avenue
Chicago, Illinois 60657

Edmund Catalog

Edmund Scientific Company
300 Edscorp Building
Barrington, New Jersey 08007

Educational Teaching Aids for Early Learning and Special Education

Education Teaching Aids Division
A. Daigger & Company
159 West Kinzie Street
Chicago, Illinois 60610

Ideal, Instructional Materials for Mathematics and Measurement, and Quality Instructional Materials for all Grades, and Milton Bradley Aids for Elementary Mathematics (4 catalogs)

STAS Instructional Materials, Inc.
2100 Fifth Street
Berkley, California 94710

J. Weston Walch Catalog

J. Weston Walch, Publisher
Box 1075
Portland, Maine 04104

Lakeshore Curriculum Materials

Lakeshore Curriculum Materials Equipment Company
1144 Montague Avenue
Box 2116
San Leandro, California 94577

Math Media Catalog

Math Media Division
H & M Associates
P.O. Box 1107
Danbury, Connecticut 06810

Math and Things (SEE), Inc.

Selective Educational Equipment, (SEE), Inc.
Three (3) Bridge Street
Newton, Massachusetts 02195

Mathematics U.S.A.

Midwest Publications Inc.
P.O. Box 129
Troy, Michigan 48084

National Textbook Company
8259 Niles Center Road
Skokie, Illinois 60076

Secondary Teaching Aids

Math-Master
Division of Gamco Industries, Inc.
Box 1911A
Big Spring, Texas 79720

SRA-Catalog

Science Research Associates, Inc.
259 East Erie Street
Chicago, Illinois 60611

Walker Educational Catalog

Walker Educational Book Corporation
720 Fifth Avenue
New York, New York 10019